Rapid Field Sampling and Analysis: Air Contaminants Following September 11 Pentagon Terrorist Strike

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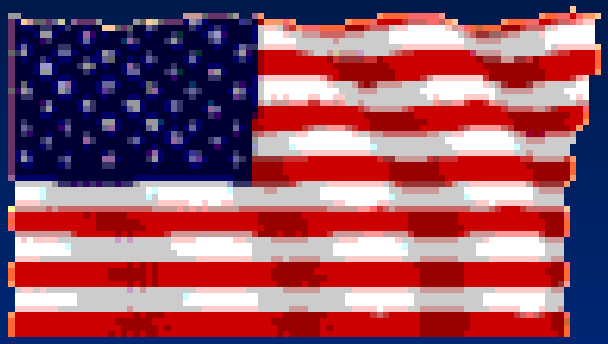


Purpose

To describe the rapid sampling and analysis methods performed by the USUHS at the Pentagon as part of the Multi-service response effort

Outline

- SPME: background/theory overview
- Indoor air screening
- Ambient air sampling
- Military public health response assets
- Conclusion

Solid Phase Microextraction

PME is a rapid, simple and sensitive method f field qualitative sampling and analysis

Non-exhaustive, equilibrium sampling process

Analytical capability away from a fixed lab faci
"Tail gate chemistry"

Other SPME work at USU covered by
CDR (Sel) Gary Hook

Steps To Sample Analysis

Action

Evaluation

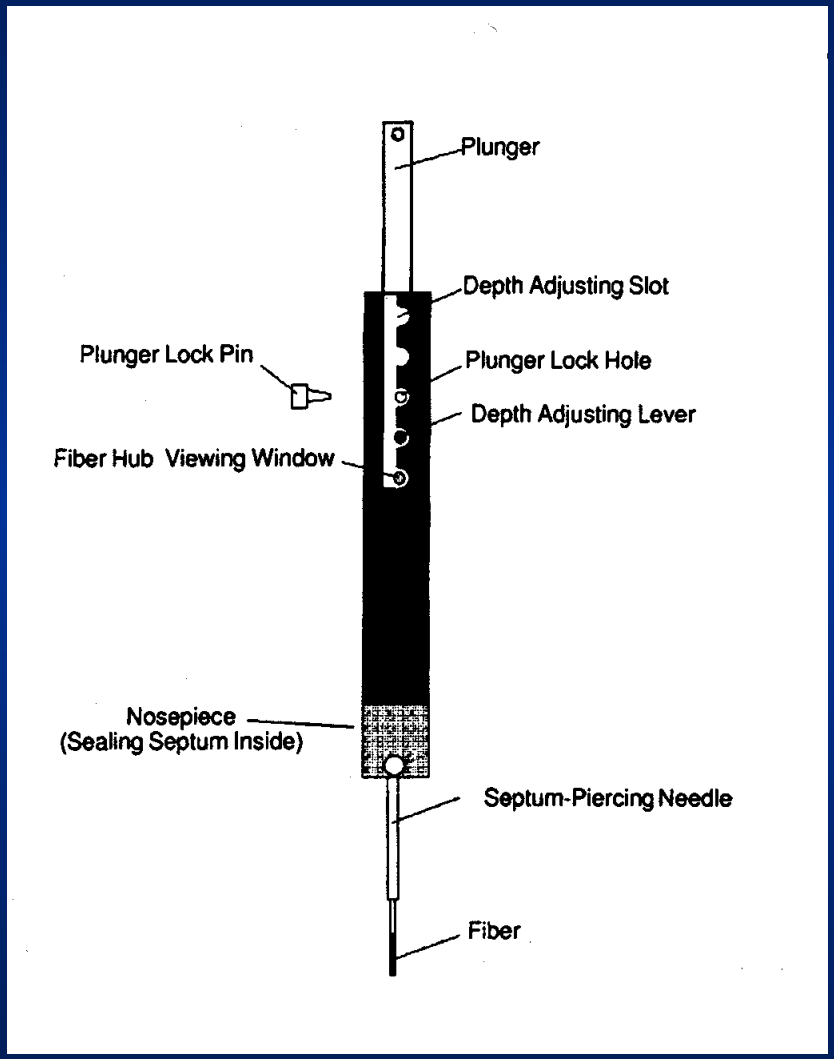
Quantitation

Separation

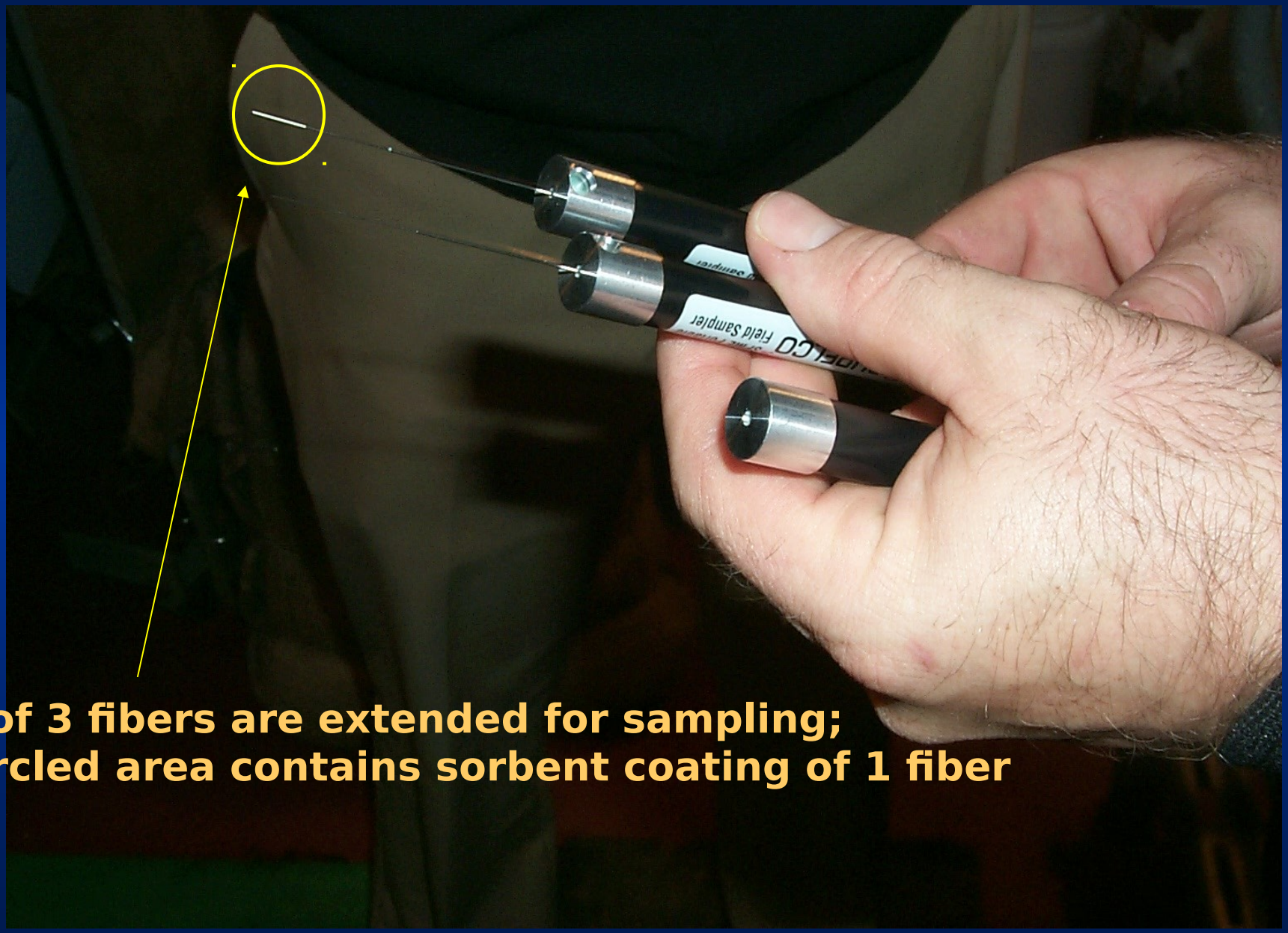
Sample Preparation

Sampling

SPME Field Sampler



From: Applications of Solid Phase Microextraction, Janusz Pawliszyn, 1999



2 of 3 fibers are extended for sampling;
Circled area contains sorbent coating of 1 fiber

Theoretical Aspects of SPME

SPME sampling/analysis:

-Partitioning of analyte between sample and coating

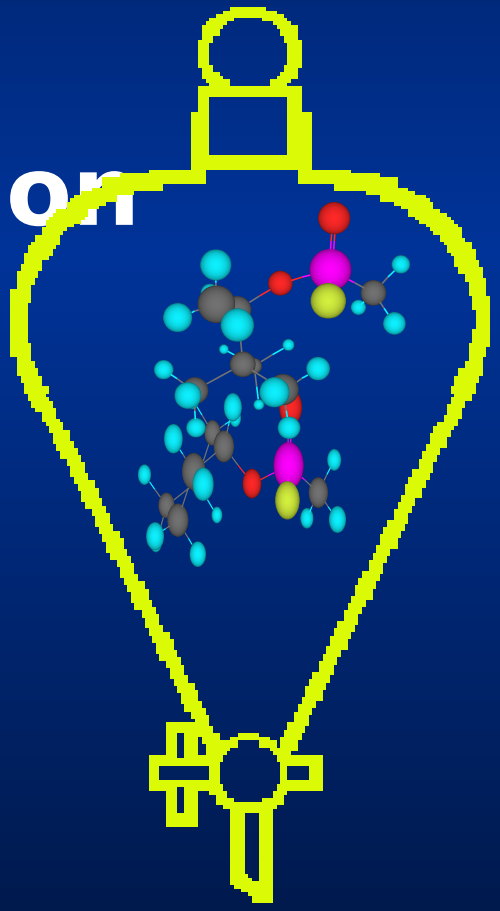
-Desorbtion into analytical instrument

Amount of analyte absorbed at equilibrium with “large” sample relative to fiber analyte capacity (usual case):

$$n = K_{fs} V_f C_o$$

Factors That Affect Extraction Efficiency (Aqueous Samples)

- Salt concentration
- pH
- Temperature



Factors That Affect Extraction Efficiency (Solid Samples)

- Temperature
- Water
- Solvents

SPME Coatings

FIBER POLARITY

Nonpolar

- Polydimethylsiloxane (PDMS)

Semipolar

- PDMS/Divinylbenzene (DVB)
- DVB/Carboxen-PDMS
- Carboxen-PDMS

Polar

- Polyacrylate (PA)
- Carbowax/DVB

FIBER SORPTION

Absorptive

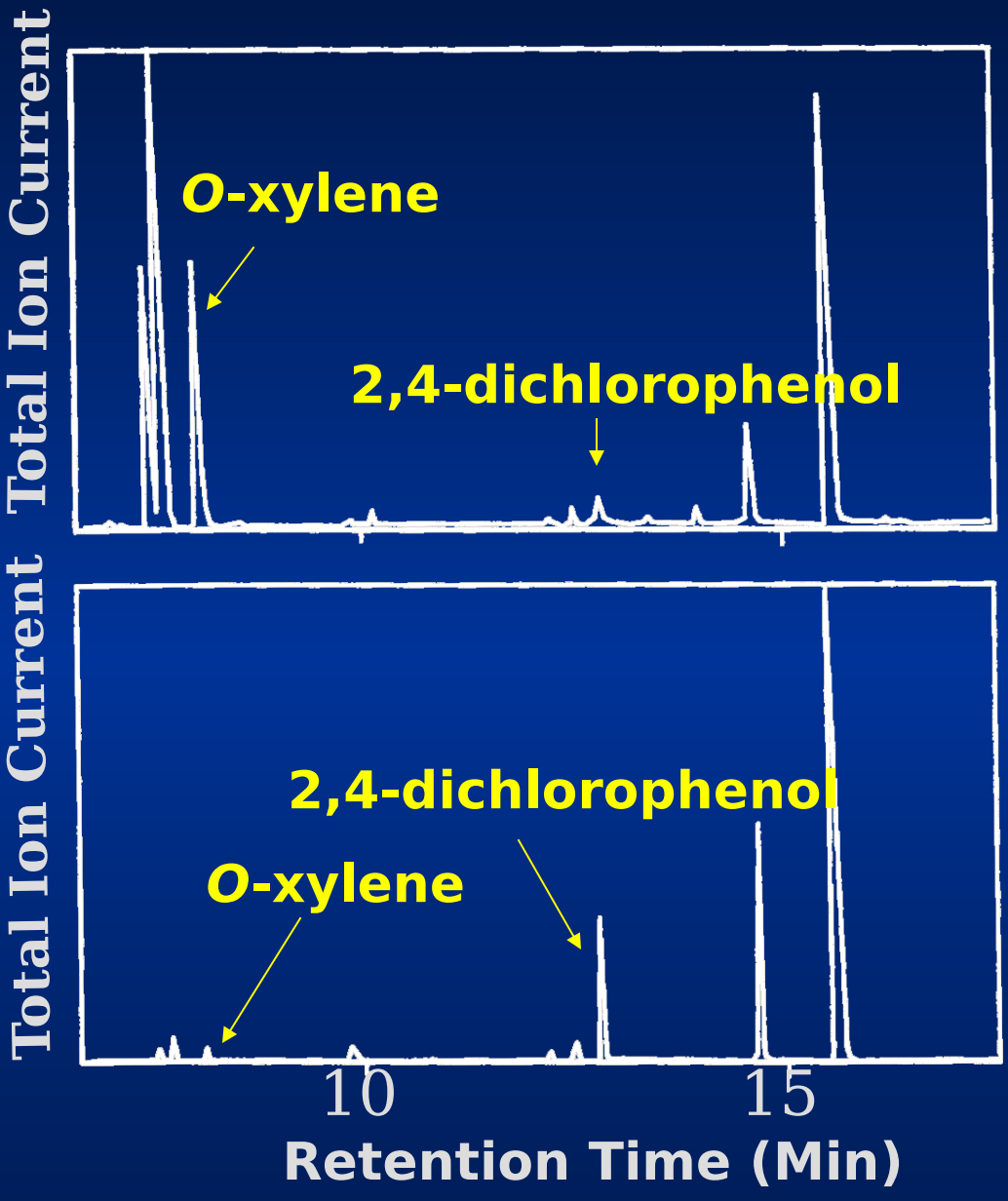
- Polydimethylsiloxane (PDMS)
- Polyacrylate (PA)

Adsorptive

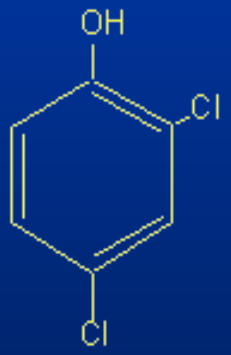
- PDMS/Divinylbenzene (DVB)
- DVB/Carboxen-PDMS
- Carboxen-PDMS
- Carbowax/DVB

PDMS

PA



O-xylene



2,4-dichlorophen

Pawliszyn, J. Solid Phase Microextraction, Theory and Practice; Wiley1997

Usefulness of SPME for Field Sampling

Passive, portable system

For gas sampling, partitioning behavior (K_{fg}) is controlled by temperature of system (fugacity altered)

SVOC compounds (e.g., PCBs, PAHs) can be heated to the point where volatility is sufficient to sample

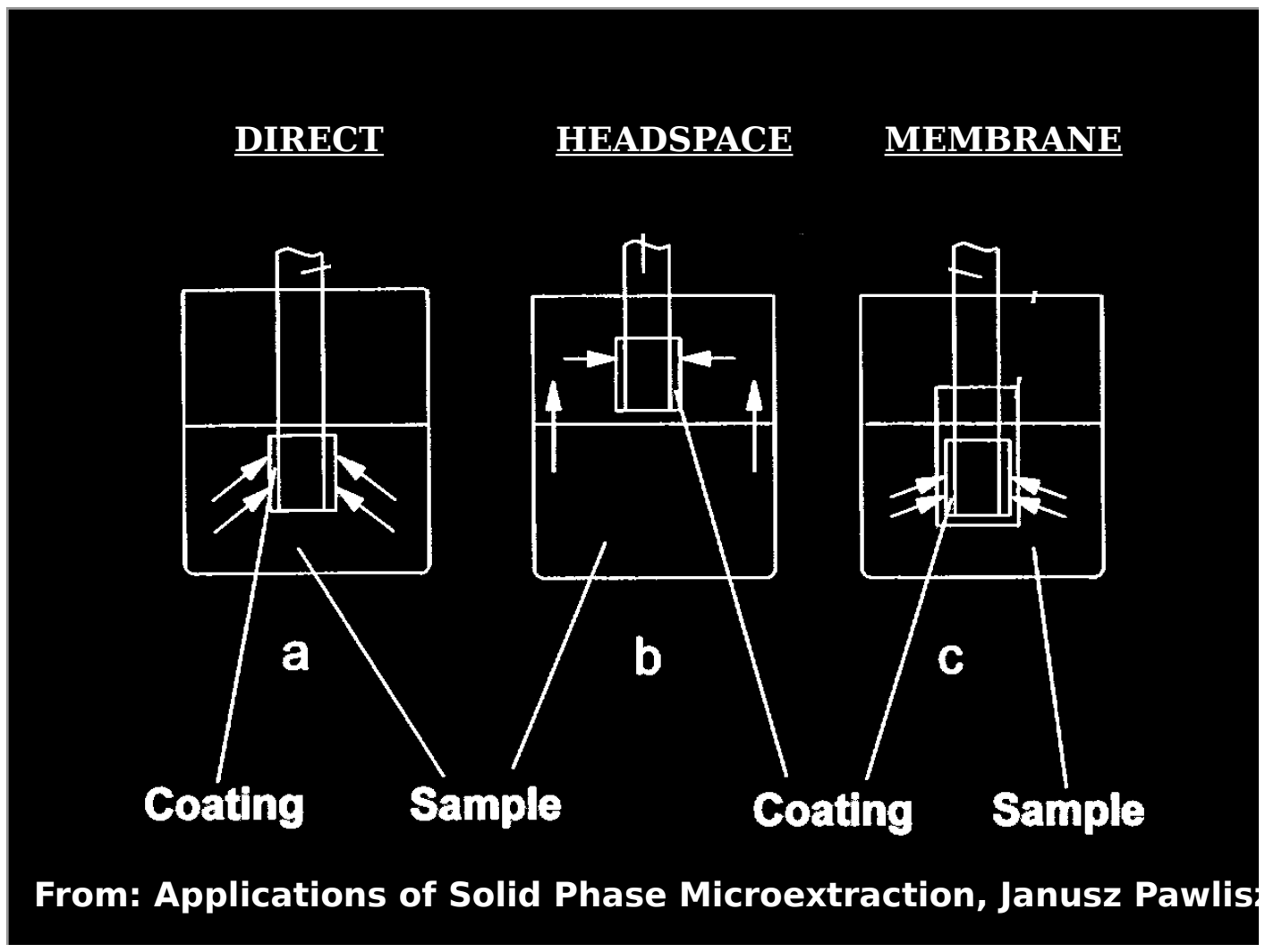
Concentrates the sample

No sample preparation = no solvents

Well suited for sampling a wide range of organic compounds:

- **soil headspace volatiles/semi-volatiles**
- **water headspace volatiles/semi-volatiles**
- **direct sampling of volatiles in air or organics in**

Usefulness of SPME for Field Sampling (con't)



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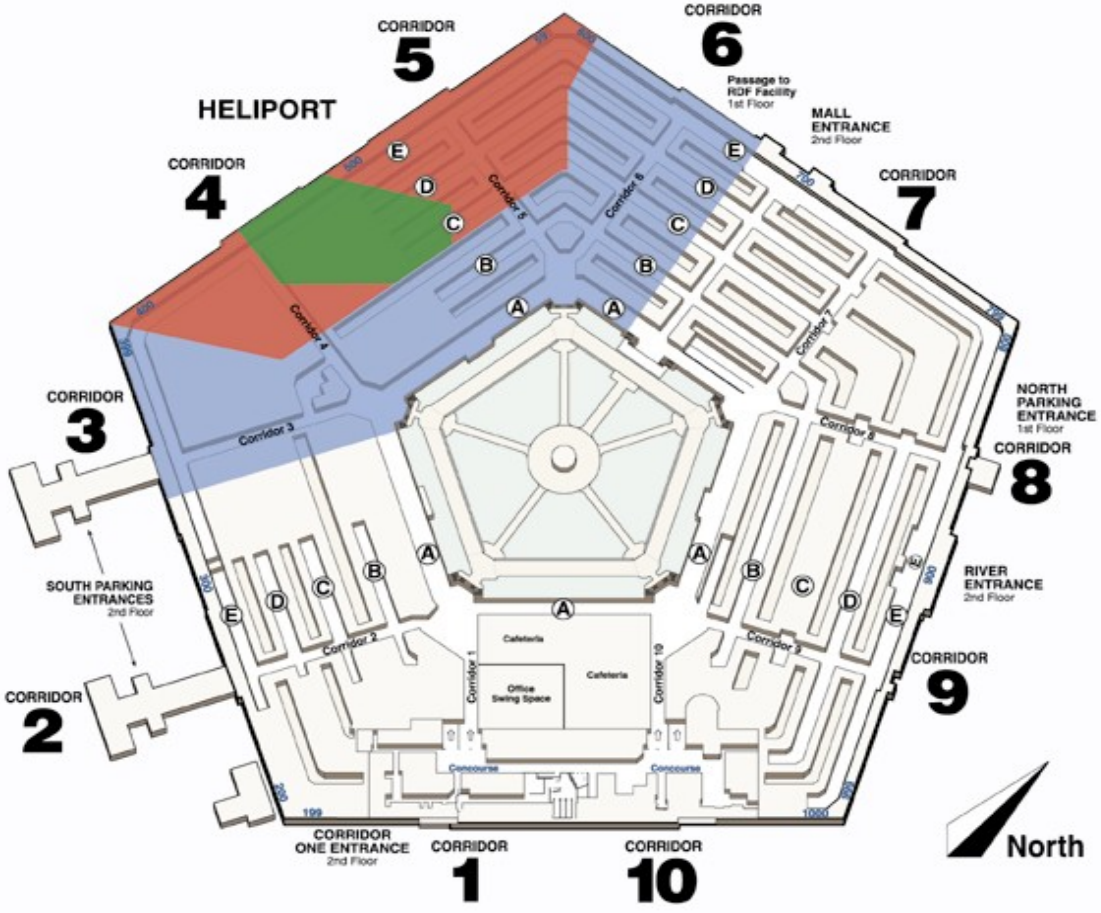
Field Portable GC/MS

DOCKMASTER
DOCKMASTER

Real Estate & Facilities
Initial Damage Assessment

SECOND FLOOR



- Structure Damage
- Fire Damage
- Water and Smoke Damage

Sep 14, 2001 1300

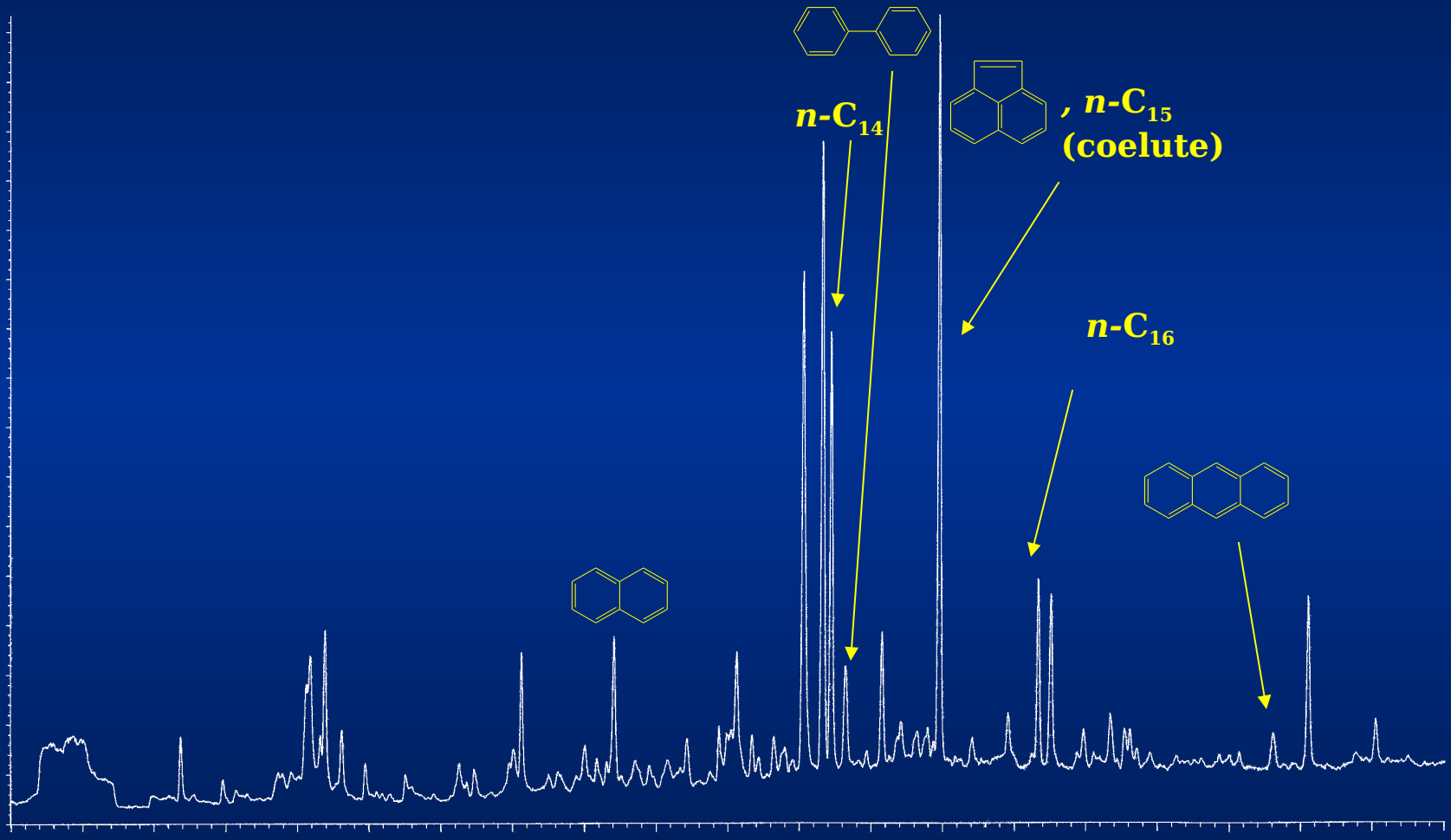
Indoor Air Sampling Following Terrorist Attack

Array of 5 fiber types

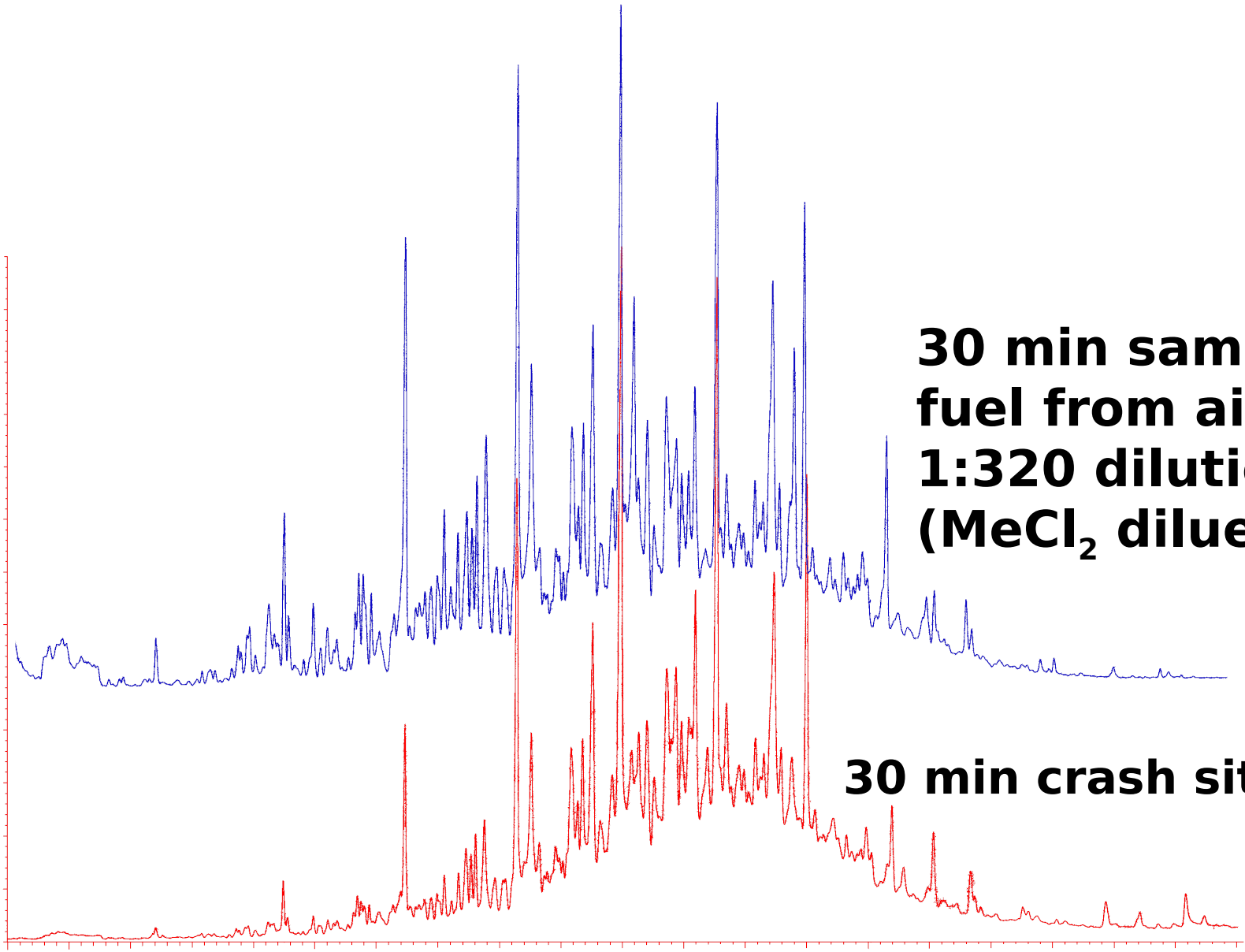
1. PDMS
2. PA
3. CW/DVB
4. PDMS/DVB
5. CAR/PDMS

IAQ Sample, Stairwell 52C

DMS Fiber, 30 min Sample Time, On-Site GC/MS Analys



Indoor Air Sampling Following Terrorist Attack


30 min sample,
fuel from aircraft
1:320 dilution
(MeCl2 diluent)
30 min crash site samp

United States Army Center for Health Promotion and Preventive Medicine

Special Medical Augmentation Response Team - Preventive Medicine

(SMART-PM)

Mission

Provide short duration Expert Preventive Medicine Augmentation to Department of Defense (DOD), other Federal, State and Local Agencies responding during the consequence management phase of regional and domestic emergencies, civil-military cooperative actions, weapons of mass destruction (WMD), humanitarian and disaster relief operations.

Composition

- **Coordinating Element**
  - **Two Technical/Operations Officers**
  - **Serve as Liaisons to Supported Commands and/or Disaster Field Offices**
  - **Trained in Emergency Response Structure, Incident Command System, Hazardous Worker Protection and Risk Communication…**
- **Technical Element**
  - **Active Duty Military and DOD Civilian Experts**
  - **Provide Support Activities Tailored for Specific Augmentation Requirements**

Information System Specialist

Safety and Occupational Health Specialist

Animal Care Specialist

Acoustical Engineer

Medical Laboratory Specialis

Entomologist

Toxicologist

Marine Biologist

Fire Protection Engineer

Occupational Health Nurse

Audiologist

Psychologist

Agronomist

Physicist

Veterinary Pathologist

Meteorologist

Biologist

Dental Officer

Mechanical Engineer

Wildlife Biologist

Medical Officer

Epidemiologist

Safety Engineer

Physical Therapist

Electrical Engineer

Industrial Hygienist

Environmental Engineer

Chaplain

Optometrist

Social Worker

Geologist

Community Health Nurse

Environmental Protection Specialist

Ergonomist

Sanitary Enginee

Environmental Law Attorney

Dietitian

Chemist

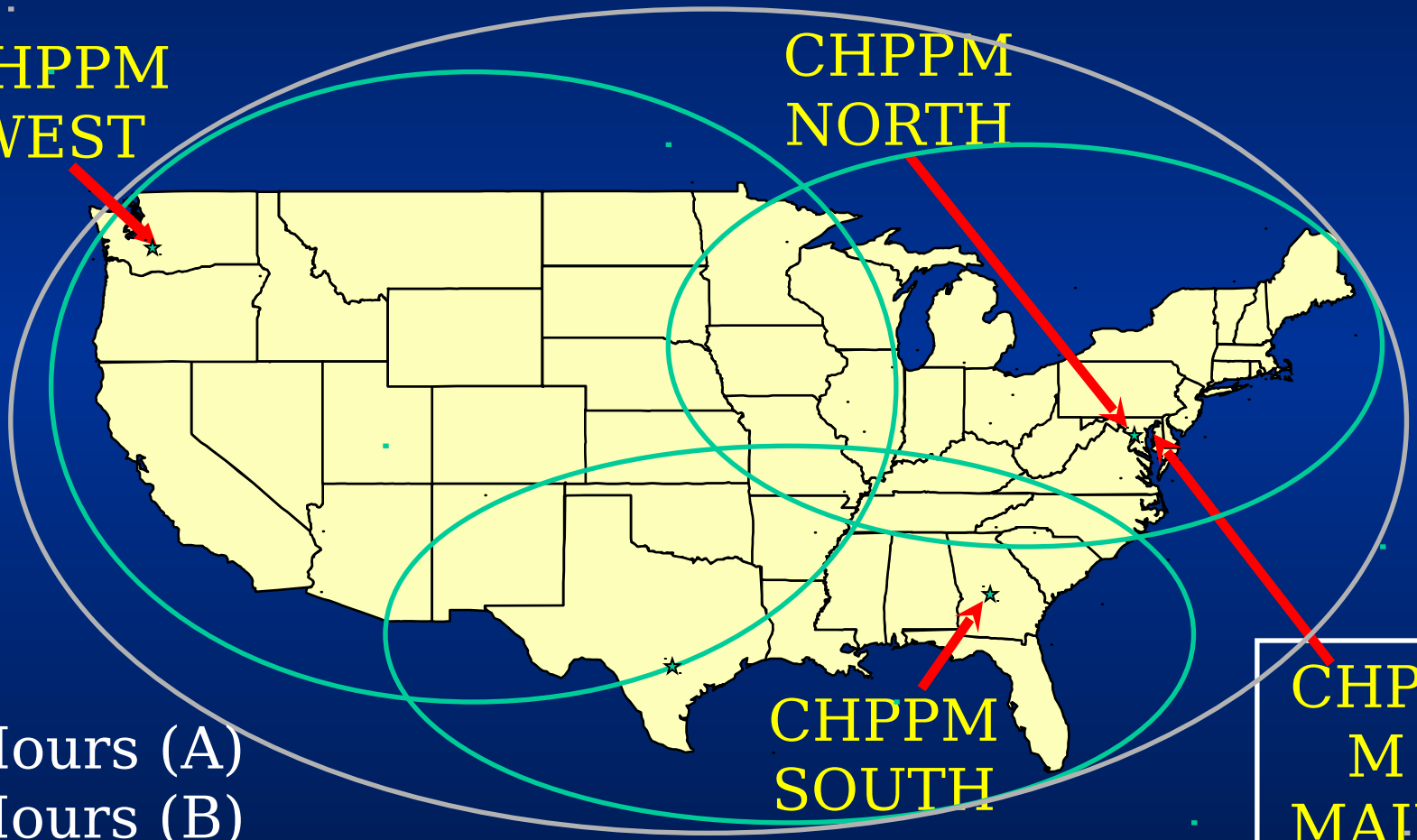
Preventive Medicine Physicia

Health Physicist

Environmental Scientist

Nuclear Medical Science Officer

Locations



12 Hours (A)
24 Hours (B)
4 Hours Local Response

Stars indicate location of Regional Medical Planning Office

Capabilities

Specialize in Reentry and Restoration Planning and Assessment

- Conduct Hazard Identification
- Conduct Risk Assessment
- Conduct Risk Control Planning & Communication

- Nuclear
- Chemical (CWA)
- TIC/TIM
- Epidemiology

Usefulness in Emergency Response & WMD (Augmentation Role) (1)

- **Reentry and Restoration**
  - **Health Physics and Public Health Consultation (Nuclear/Radiological)**
  - **Public Health Consultation in Epidemiology, Entomology, Occupational & Environmental Health and Hazard Countermeasures Planning**
  - **Public Health Risk Assessment (Chemical)**
  - **Hazard Mapping and Modeling**
  - **DOD Technical Liaisons**

Usefulness in Emergency Response & WMD (Augmentation Role) (2)

- **Reentry and Restoration**
  - **Provide Professional Augmentation to Existing Civilian and Military Health and Environmental Response Assets in Extended Emergencies**
  - **Provide Public Health and Environment Sciences Expertise for DOD**
  - **Advise DOD Assets on Force Health Protection Countermeasures**

Important Facts

- **Not a First Response Asset**
- **Only Self Sustainable for 72 Hours**
- **Limited Direct Support Asset (Hazard Mapping and Modeling, Limited Sampling / Analysis Capabilities)**
- **Major Functions are Public Health Assessment, Consultation, and Hazard Countermeasures Planning**

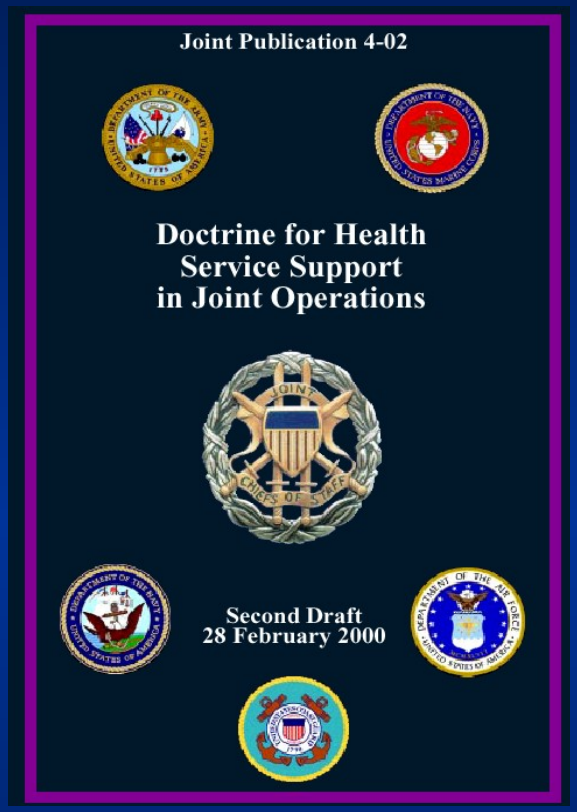
Normal Supported CMDs/Activities

- **Outside Continental United States:**
  - **Unified Commands (CINCs)**
  - **520th Theater Army Medical Laboratory (TAML)**
- **Domestic Emergencies:**
  - **Director of Military Support (DOMS) / U.S. Atlantic Command (USACOM) / Response Task Force (RTF)**
    - **ESF-3, Public Works and Engineering**
    - **ESF-8, Health and Medical Services (Public Health - Non-Patient Care)**
    - **ESF-10, Hazardous Materials**
- **Domestic Weapons of Mass Destruction Emergencies:**
  - **DOD Chemical/Biological Rapid Response Team C/B-RRT**

The other Multi-service Component

- Air Force IH from Andrews, Bolling, Keesler AFB
- Navy IH from National Naval Medical Center
- Navy Biological Agent sampling from Naval Medical Research Center
- IH & Occ Health from NARMC, WRAMC and DiLorenzo TriCare Health Clinic

USUHS's Contribution



- **DODD 6490.2, Joint Medical Surveillance, 30 Aug 97.***
- **DODI 6490.3 , Implementation and Application of Joint Medical Surveillance for Deployments, 7 Aug 97***
- **Require the Department of Defense through the Joint Staff, Combatant Commands, and Military Services to:**
  - ***"identify and assess potential hazards, and evaluate and document actual exposures….."***

Conclusions

- Simple field use for screening with MS identification
- No sample preparation
- Simple solvent-free analysis
- High sensitivity -all sample is analyzed, no solvent backgro
- Quantitative sampling possible for equilibrium as well as dy exposures
- SPME is useful for most analytes suitable for GC analysis
- A wide range of organic compounds may be sampled

Questions?